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A Journal of Scottish Natural History

THE SCOTTISH NATURALIST

Founded 1871

A Journal of Scottish Natural History

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The *Scottish Naturalist,* now published by the Scottish Natural History Library, is an independent journal primarily devoted to the study of Scottish natural history. It was founded in 1871 by Dr. F. Buchanan White, of Perthshire, and in 1988 completed one hundred years of publication. For a summary of the record of publication, see the inside back cover.

Although the journal's main interests have always centred on the history and distribution of Scottish fauna and flora, it is prepared to publish contributions on the many aspects of Scottish natural science embraced by its title, including Zoology, Botany, Geology, History, Geography, Medicine and the allied sciences, Archaeology, and the Environment.

All papers and notes for publication, or books for review, should be sent to the Editors at the Scottish Natural History Library, Foremount House, Kilbarchan, Renfrewshire PA10 2EZ.

Contributions should be clearly written; whenever possible they should be typed, double-spaced, on one side of the paper, with adequate margins, and should try to conform to the general style and arrangement of papers and notes in the current number of the journal. Maps, diagrams and graphs should be drawn in black ink on white unlined paper. Photographs should be on glossy paper. Proofs of all contributions will be sent to authors and should be returned without delay.

Authors of papers, but not of short notes, will receive thirty reprints in covers free of charge. Additional reprints may be ordered, at cost, when the proofs are returned.

The *Scottish Naturalist* is usually published three times a year. The standard annual subscription is £35.00, which should be sent to the Editors at the Library address. Members of recognised natural history organisations, however, can receive the *Scottish Naturalist* at a greatly reduced subscription; for details apply to the Editors.

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THE SCOTTISH NATURALIST

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A Journal of Scottish Natural History

With which is incorporated *The Annals of Scottish Natural History* and *The Western Naturalist*

115th Year 2003

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The *Scottish Naturalist* is the national journal of Scottish natural history. It was founded in 1871 by Dr. F. Buchanan White, of Perthshire, and in 1988 completed one hundred years of publication. The journal exists to provide a medium for the publication of original work on all aspects of Scottish natural science. All contributions, however, represent the personal opinions of the authors concerned, and do not necessarily reflect the views of the Editors of the *Scottish Naturalist.*

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VERTEBRATE ZOOLOGY IN THE SCOTTISH NATURALIST

A Classified Index of all Contributions on Vertebrate Zoology in the *Scottish Naturalist* from its Commencement in 1871 to the end of the Year 2000

Part 4: 1926-1950

4b: *Scottish Naturalist* 1948-1950

By J.A. GIBSON
Representative for Scotland,
Society for the History of Natural History

This fourth part (continued) of the survey of the contributions on vertebrate zoology in the *Scottish Naturalist* covers the second quarter of the 20th century, from 1926 to 1950. The first three parts dealt with the Introduction (Gibson, 1998a), the thirty years from the commencement of the journal in 1871 until 1900 (Gibson, 1998b) and the first quarter of the 20th century, from 1901 to 1925 (Gibson, 2000 and 2001).

From 1926 the *Scottish Naturalist* continued to be published six times a year until the end of 1939, when publication was suspended for the duration of the second world war and the years immediately thereafter. The journal recommenced publication in 1948, being then published three times a year. As already indicated, however, as with Part 3 (1901-1925), the number of contributions in the quarter-century from 1926 to 1950 is also quite substantial (nearly 1,500 items), so a decision was made also to divide this section into two parts, with the obvious division coming at the end of 1939 (Part 4a). This section of the bibliography (Part 4b), continued from 1926-1939 (Gibson, 2002), contains the Chronological List from 1948 to 1950, thus concluding the relevant quarter-century, and also contains the entire Faunal Area Distribution index from 1926 to 1950 inclusive.

When the journal was restarted in 1948, the Editors at the time, who were possibly not too well versed in the past history of the journal, decided to reintroduce volume numbers, but unfortunately did so without consulting those Scottish naturalists best able to advise. Counting the volume numbers (not years) issued from the commencement of the journal in 1871, when each volume originally consisted of two years, the Editors most unfortunately miscounted the volumes, apparently overlooking the single year/volume of 1891 (3rd series,

Volume 1; see Gibson, 1997) and had the first cover for 1948 incorrectly numbered and printed as Vol. 59, No. 1, April 1948, instead of Vol. 60; this error was repeated at the head of the Editorial on page 1.

When preliminary copies of this first part of the journal were circulated to the sponsors, an anguished telephone call from the present writer drew attention to the fact that the volume number should be 60, not 59, whereupon the cover and the editorial heading were hastily corrected and reprinted before general distribution of the journal to the subscribers. The Scottish Natural History Library still possesses a copy of the original preliminary printing, with the incorrect numbering of 59. Unfortunately it was too late to correct another, and later discovered, error, in the text of the first Editorial - which had by then been printed, where it was stated that the *Annals of Scottish Natural History* was first issued three times a year, whereas the *Annals* had always been issued four times a year during its entire twenty years of publication.

At the suggestion of the present writer, a 'Notice to Librarians' was inserted on the *verso* of the half-title at the completion of the 1948 volume, to draw attention to the correct position, but unfortunately when this was printed, without a proof having been seen for checking, yet another error appeared - "numbered in two series" instead of "three series". It is very regrettable that attention now has to be drawn to these previous editorial errors, but the record has to be set straight.

As has already been indicated, so far throughout this entire bibliography all previous 'volume numbers' (which can be very confusing) have been discarded, and the journal is referred to only by year of publication, which is completely unambiguous. This arrangement is continued, and all items are listed in chronological order, referenced by author(s), title, name of journal, year of publication, and pagination. A change will be taking place, however, as undernoted:

The *Scottish Naturalist* was founded in 1871, and was published yearly without a break until the end of 1939, when there was an unavoidable gap in publication during and just after the years of the second world war (see above). The journal restarted publication in 1948 and, apart from a temporary gap of three years (1958-1960) because of financial difficulties, was published regularly until 1964. There then followed a longer gap in publication (1965 to 1971), partly for fairly similar financial reasons, but regular publication recommenced in 1972 (under the deliberately temporary name of the *Western Naturalist* - see Editorial, 1983: 3-5), fortunately with continued success, and in 1988 the *Scottish Naturalist* completed 100 years of publication.

At that time, after considerable discussion, it was decided to (re-)introduce volume numbers, from 100 onwards, each representing one year of publication, so commencing with 1988 the journal was numbered Volume 100, with consecutive volume numbering thereafter. In this adoption of simple yearly volume numbers from the centenary, instead of a previously erratic or variable system, the *Scottish Naturalist* is in good company; e.g. the *Ibis*, journal of the British Ornithologists' Union, formerly numbered in fourteen separate series since 1859, changed to yearly volume numbers, commencing as Volume 85, from 1943. This simple and easily identifiable system is in keeping with modern standard practice for journals with yearly volume publication.

It was considered desirable to announce this change of practice well in advance of the 1975-2000 section of the bibliography, where the reintroduction of volume numbering takes place, since it will have been noticed that post-1987 references to the *Scottish Naturalist* in the preliminary sections of this present bibliography have already been given by volume numbers,. Up to and including 1987, therefore, the journal is referenced by year of publication, but from 1988 all reference is by volume number, from Volume 100 onwards. It is recommended that this practice be followed by all concerned.

The next part of the bibliography will cover the quarter-century from 1951 to 1975.

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Area: Gen

4213 **Bruce, S.** (1948). The Red-flanked Bluetail in Shetland: the first British record. *Scottish Naturalist,* **1948**: 6.
Class: Bird
Area: SH

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Class: Bird
Area: Gen SH

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Class: Bird
Area: Gen

4216 **Baxter, E.V.** (1948). A century's changes in Scottish ornithology. *Scottish Naturalist,* **1948**: 11-19.
Class: Bird
Area: Gen SO TW CL FO TA DE MO CS NW AG IH OH SK OL OR SH

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Class: Bird
Area: FO

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Class: Bird
Area: DE MO

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Area: Gen

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Area: Gen

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Area: TW

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Class: Fish
Area: Gen MO

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Area: FO

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Area: TA

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Area: FI

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Class: Bird
Area: SH

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Class: Bird
Area: Gen CL

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Class: Bird
Area: Gen

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Class: Bird
Area: Gen

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Area: CS

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Area: CS

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Area: MO

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Class: Bird
Area: FO

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Area: FO

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Area: Gen TA

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Area: Gen CS

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Area: Gen

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Area: Gen DE

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Area: Gen FO TA FI

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Area: Gen TA

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Area: Gen TA

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Area: Gen SH

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Class: Fish
Area: TA MO

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Class: Bird
Area: MO

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Class: Bird
Area: Gen FO

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Class: Bird
Area: FO

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Class: Bird
Area: FO

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Class: Bird
Area: Gen NW

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Class: Bird
Area: Gen NW

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Class: Bird
Area: TA

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Class: Bird
Area: Gen FO

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Class: Bird
Area: NW

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Class: Bird
Area: NW

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Class: Bird
Area: Gen TW

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Class: Bird
Area: OR

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Class: Bird
Area: OR

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Class: Bird
Area: Gen DE

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Class: Bird
Area: Gen DE

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Class: Bird
Area: Gen DE

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Class: Bird
Area: Gen

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Class: Bird
Area: TA

4263 **Rayfield, P.A.** (1948). Gadwall in Wester Ross. *Scottish Naturalist,* **1948**: 133.
Class: Bird
Area: NW

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Class: Bird
Area: Gen NW

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Class: Bird
Area: Gen

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Class: Bird
Area: NW

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Class: Bird
Area: Gen CS OH OR

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Class: Bird
Area: NW

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Class: Bird
Area: NW

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Class: Bird
Area: FO

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Area: FO

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Area: Gen FO

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Class: Bird
Area: Gen NW

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Class: Mamm
Area: Gen DE

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Class: Bird
Area: FI

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Class: Bird
Area: Gen MO

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Class: Bird
Area: SH

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Area: Gen SO TW CL FO TA DE MO CS NW AG IH OH OR

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Area: Gen SO TW CL FO TA DE MO CS NW AG IH OH SH

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Area: FO

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Class: Bird
Area: FO

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Class: Mamm Bird
Area: Gen

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Class: Bird
Area: Gen

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Class: Bird
Area: TW

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Area: TW

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Class: Bird
Area: TA

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Class: Bird
Area: TA

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Class: Bird
Area: TA

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Class: Bird
Area: TA

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Class: Bird
Area: FO

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Class: Bird
Area: FO

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Class: Bird
Area: Gen FO

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Class: Bird
Area: Gen TA

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Class: Bird
Area: FO

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Class: Bird
Area: FO

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Class: Bird
Area: Gen CL

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Class: Bird
Area: IH

4298 **Mylne, C.K.** (1948). Possible breeding of Grasshopper Warbler in Midlothian. *Scottish Naturalist,* **1948**: 218.
Class: Bird
Area: FO

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Class: Bird
Area: FO

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Class: Bird
Area: AG

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Class: Bird
Area: NW

4302 **Editorial comment.** (1948). Possible breeding of the Blackcap in the Highlands. *Scottish Naturalist,* **1948**: 219.
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Area: CS NW

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Class: Bird
Area: MO

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Class: Bird
Area: Gen MO AG IH

4306 **Baxter, E.V. and Rintoul, L.J.** (1948). Gadwall in north Perth. *Scottish Naturalist,* **1948**: 220.
Class: Bird
Area: TA

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Area: IH

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Class: Bird
Area: NW

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Class: Bird
Area: Gen CL DE MO SH FI

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Area: Gen SH

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Area: FI

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Class: Rept Amph
Area: Gen SO CL MO SH

4325 **Stephen, A.C.** (1949). *Chimaera* or Rabbit-Fish at North Berwick. *Scottish Naturalist,* **1949**: 117.
Class: Fish
Area: FO

4326 **Stephen, A.C.** (1949). Tadpole-Fish at North Berwick. *Scottish Naturalist,* **1949**: 117.
Class: Fish
Area: FO

4327 **Marshall, W.** (1949). Shrews in upper Strathspey. *Scottish Naturalist,* **1949**: 117-118.
Class: Mamm
Area: MO

4328 **McAinsh, J.D.** (1949). Magpies in Stirlingshire. *Scottish Naturalist,* **1949**: 118.
Class: Bird
Area: FO

4329 **Halliday, H.** (1949). Chaffinch nesting on wagon brake block. *Scottish Naturalist,* **1949**: 118.
Class: Bird
Area: Gen FO

4330 **Halliday, H.** (1949). Snow Bunting in west Midlothian. *Scottish Naturalist,* **1949**: 118-119.
Class: Bird
Area: FO

4331 **Editorial note.** (1949). [Abundance of Snow Buntings during winter 1948-49]. *Scottish Naturalist,* **1949**: 119.
Class: Bird
Area: Gen

4332 **Rayfield, P.A.** (1949). Tree-Pipit singing on passage. *Scottish Naturalist,* **1949**: 119.
Class: Bird
Area: Gen NW

4333 **Campbell, J.W.** (1949). Pied Flycatcher in north Perth. *Scottish Naturalist,* **1949**: 119.
Class: Bird
Area: TA

4334 **Airey, A.F.** (1949). Grasshopper Warbler in Stirlingshire. *Scottish Naturalist,* **1949**: 119.
Class: Bird
Area: CL

4335 **Editorial note.** (1949). [Status of Grasshopper Warbler in west Stirling]. *Scottish Naturalist,* **1949**: 119-120.
Class: Bird
Area: CL

4336 **Rayfield, P.A.** (1949). Sedge Warblers increase in Wester Ross. *Scottish Naturalist,* **1949**: 120.
Class: Bird
Area: NW

4337 **Editorial note.** (1949). [Status of Sedge Warblers in Wester Ross]. *Scottish Naturalist,* **1949**: 120.
Class: Bird
Area: NW

4338 **Morrison, R.I.** (1949). Sedge Warbler in west Sutherland. *Scottish Naturalist,* **1949**: 120.
Class: Bird
Area: CS

4339 **Clancey, P.A.** (1949). The Iceland Redwing in Argyllshire. *Scottish Naturalist,* **1949**: 120.
Class: Bird
Area: CL AG

4340 **Maxwell, W.H.** (1949). Nesting of the Barn Owl in Banffshire. *Scottish Naturalist,* **1949**: 120-121.
Class: Bird
Area: MO

4341 **Christison, P.** (1949). Golden Eagle *versus* Wild Cat. *Scottish Naturalist,* **1949**: 121-122.
Class: Mamm Bird
Area: NW

4342 **Thomson, W.** (1949). Montagu's Harrier in East Lothian. *Scottish Naturalist,* **1949**: 122.
Class: Bird
Area: FO

4343 **Editorial note.** (1949). Scottish records of Montagu's Harrier. *Scottish Naturalist,* **1949**: 122.
Class: Bird
Area: Gen SO FO OR

4344 **Thomson, W.** (1949). Bittern in East Lothian. *Scottish Naturalist,* **1949**: 122.
Class: Bird
Area: FO

4345 **Editorial note.** (1949). [Bittern in East Lothian]. *Scottish Naturalist,* **1949**: 122.
Class: Bird
Area: FO

4346 **Hughes-Onslow, G.** (1949). Grey Geese in Ayrshire. *Scottish Naturalist,* **1949**: 123.
Class: Bird
Area: CL

4347 **Watson, D.** (1949). Garganey in East Lothian. *Scottish Naturalist,* **1949**: 123.
Class: Bird
Area: FO

4348 **Editorial note.** (1949). [Status of Garganey in Scotland]. *Scottish Naturalist,* **1949**: 123.
Class: Bird
Area: Gen FO

4349 **Hamilton, D.** (1949). Wigeon breeding at Linlithgow Loch. *Scottish Naturalist,* **1949**: 123-124.
Class: Bird
Area: FO

4350 **Boase, H.** (1949). American Wigeon in Angus. *Scottish Naturalist,* **1949**: 124.
Class: Bird
Area: TA

4351 **Editorial note.** (1949). [Status of American Wigeon in Scotland]. *Scottish Naturalist,* **1949**: 124.
Class: Bird
Area: Gen

4352 **Brock, E.R.** (1949). Ferruginous Duck near Dumbarton. *Scottish Naturalist,* **1949**: 124.
Class: Bird
Area: CL

4353 **Editorial note.** (1949). [Status of Ferruginous Duck in Scotland]. *Scottish Naturalist,* **1949**: 124.
Class: Bird
Area: Gen CL

4354 **Rayfield, P.A.** (1949). Turtle Dove in Wester Ross. *Scottish Naturalist,* **1949**: 124.
Class: Bird
Area: NW

4355 **Editorial note.** (1949). [Turtle Dove an occasional visitor to Wester Ross]. *Scottish Naturalist,* **1949**: 124.
Class: Bird
Area: NW

4356 **Sandeman, G.L.** (1949). Phalaropes in Midlothian. *Scottish Naturalist,* **1949**: 125.
Class: Bird
Area: FO

4357 **MacDonald, R.** (1949). Phalaropes in Midlothian. *Scottish Naturalist,* **1949**: 125.
Class: Bird
Area: FO

4358 **MacDonald, D.** (1949). Curlew Sandpiper in Sutherland. *Scottish Naturalist,* **1949**: 125-126.
Class: Bird
Area: CS

4359 **Watt, A.M. and Macgregor, K.S.** (1949). Temminck's Stint in East Lothian. *Scottish Naturalist,* **1949**: 126.
Class: Bird
Area: FO

4360 **Bryson, A.G.S., Sandeman, G.L., Munro, J.H.B., Waterston, G. and Watson, D.** (1949). Occurrence of American Pectoral Sandpiper, *Calidris melanotos*, in East Lothian. *Scottish Naturalist,* **1949**: 126-127.
Class: Bird
Area: FO

4361 **Rayfield, P.A.** (1949). Uncommon waders in Wester Ross. *Scottish Naturalist,* **1949**: 127-128.
Class: Bird
Area: NW

4362 **Macgregor, K.S.** (1949). Black Tern in Edinburgh. *Scottish Naturalist,* **1949**: 128.
Class: Bird
Area: FO

4363 **Williamson, K.** (1949). Fair Isle Bird Observatory. First report, 1948. *Scottish Naturalist,* **1949**: 129-143.
Class: Bird
Area: FI

4364 **Brian, A.D.** (1949). Dominance in the Great Tit *Parus major*. *Scottish Naturalist,* **1949**: 144-155.
Class: Bird
Area: Gen CL

4365 **Duncan, U.K.** (1949). Woodland into pasture. *Scottish Naturalist,* **1949**: 169-173.
Class: Mamm
Area: Gen TA

4366 **Blackwood, G.G.** (1949). Long-eared Bat *Plecotus auritus* in central Perthshire. *Scottish Naturalist,* **1949**: 176.
Class: Mamm
Area: TA

4367 **Editorial note.** (1949). [Occurrence of Long-eared Bat in central Perthshire]. *Scottish Naturalist,* **1949**: 176.
Class: Mamm
Area: TA

4368 **MacBean, A.F.** (1949). Carrion Crows attacking in flight. *Scottish Naturalist,* **1949**: 176-177.
Class: Bird
Area: Gen TA

4369 **Murdoch, C.C.I.** (1949). Cases of albinism in Jackdaw and other species. *Scottish Naturalist,* **1949**: 177.
Class: Bird
Area: Gen TA

4370 **Editorial note.** (1949). [White Jackdaw near Aberfeldy]. *Scottish Naturalist,* **1949**: 177.
Class: Bird
Area: TA

4371 **Raeburn, G.F.** (1949). Mimicry by Jays. *Scottish Naturalist,* **1949**: 177-178.
Class: Bird
Area: Gen TA

4372 **Clancey, P.A.** (1949). Increase of Goldfinch, Chiffchaff, and Great Spotted Woodpecker in east Renfrewshire. *Scottish Naturalist,* **1949**: 178-179.
Class: Bird
Area: CL

4373 **Longstaff, T.G.** (1949). North-west spread of Sedge Warbler *Acrocephalus schoenobaenus*. *Scottish Naturalist,* **1949**: 179.
Class: Bird
Area: NW

4374 **Murdoch, C.C.I.** (1949). Garden Warblers in upper Deeside. *Scottish Naturalist,* **1949**: 179-180.
Class: Bird
Area: DE

4375 **Evans, C.E.** (1949). Blackcaps in west Inverness. *Scottish Naturalist,* **1949**: 180.
Class: Bird
Area: MO AG

4376 **Longstaff, T.G.** (1949). Lesser Whitethroat *Sylvia curruca* in Coigach. *Scottish Naturalist,* **1949**: 180.
Class: Bird
Area: NW

4377 **Thomson, J.M.** (1949). Nesting of Mistle-Thrushes. *Scottish Naturalist,* **1949**: 180-181.
Class: Bird
Area: Gen FO

4378 **Campbell, J.L.** (1949). A Blackbird's song. *Scottish Naturalist,* **1949**: 181.
Class: Bird
Area: Gen IH

4379 **Cross, A.** (1949). Blackbird feeding young Wagtails. *Scottish Naturalist,* **1949**: 181-182.
Class: Bird
Area: Gen TA

4380 **Weir, R.S.** (1949). Stonechats in west Sutherland. *Scottish Naturalist,* **1949**: 182.
Class: Bird
Area: NW

4381 **Pennie, I.D.** (1949). Great Spotted Woodpecker in north Sutherland. *Scottish Naturalist,* **1949**: 182.
Class: Bird
Area: CS

4382 **Clancey, P.A.** (1949). On the extinct Scottish Great Spotted Woodpecker and Capercailzie, with a suggestion for systematic treatment. *Scottish Naturalist,* **1949**: 182-183.
Class: Bird
Area: Gen

4383 **Editorial note.** (1949). [On the extinct Scottish Capercailzie]. *Scottish Naturalist,* **1949**: 184.
Class: Bird
Area: Gen

4384 **Walls, F.D.E.** (1949). Garganey in Ayrshire. *Scottish Naturalist,* **1949**: 184.
Class: Bird
Area: CL

4385 **Editorial note.** (1949). [Apparent first record of Garganey for Ayrshire]. *Scottish Naturalist,* **1949**: 184.
Class: Bird
Area: CL

4386 **Walls, F.D.E.** (1949). Shoveler nesting in Ayrshire. *Scottish Naturalist,* **1949**: 184.
Class: Bird
Area: CL

4387 **Editorial note.** (1949). [Previous attempt by Shoveler to nest in Ayrshire]. *Scottish Naturalist,* **1949**: 184.
Class: Bird
Area: CL

4388 **Raeburn, G.F.** (1949). Early breeding of Wood Pigeon in Aberdeenshire. *Scottish Naturalist,* **1949**: 184-185.
Class: Bird
Area: Gen DE

4389 **Nelson, S.** (1949). Turtle Dove in Ayrshire. *Scottish Naturalist,* **1949**: 185.
Class: Bird
Area: CL

4390 **Editorial note.** (1949). [Turtle Dove an occasional visitor to Ayrshire]. *Scottish Naturalist,* **1949**: 185.
Class: Bird
Area: CL

4391 **Maw, M.C. and Kirkcaldy, S.** (1949). Black-tailed Godwits at Gladhouse, Midlothian. *Scottish Naturalist,* **1949**: 185.
Class: Bird
Area: FO

4392 **Young, W.P.** (1949). White Oyster-catcher: a twelve-year record. *Scottish Naturalist,* **1949**: 185-187.
Class: Bird
Area: Gen

4393 **Editorial note.** (1949). White Oyster-catcher [in 1949]. *Scottish Naturalist,* **1949**: 187.
Class: Bird
Area: Gen

4394 **Johnson, G.A. and Hodgkinson, L.G.** (1949). Aggressive display by Guillemot. *Scottish Naturalist,* **1949**: 187.
Class: Bird
Area: Gen CL

4395 **Anton, J.F.** (1949). Little Auk in Perthshire. *Scottish Naturalist,* **1949**: 187-188.
Class: Bird
Area: TA

4396 **Anderson, D.R.** (1949). Water Rails at Duddingston Loch. *Scottish Naturalist,* **1949**: 188.
Class: Bird
Area: FO

4397 **Macgregor, K.S.** (1949). Water Rail in Edinburgh. *Scottish Naturalist,* **1949**: 188-189.
Class: Bird
Area: FO

4398 **Anderson, J.A.** (1949). Bewick's Swans. *Scottish Naturalist,* **1949**: 191-192.
Class: Bird
Area: Gen

4399 **Mann, K.H.** (1949). Wildfowl and Leeches. *Scottish Naturalist,* **1949**: 192.
Class: Bird
Area: Gen

4400 **Boase, H.** (1950). Notes on the behaviour of some ducks. *Scottish Naturalist,* **1950**: 1-16.
Class: Bird
Area: Gen TA

4401 **Williamson, K.** (1950). Fair Isle Bird Observatory. Notes on selected species, spring 1949. *Scottish Naturalist,* **1950**: 17-25.
Class: Bird
Area: FI

4402 **Fisher, J. and Piercy, K.** (1950). Notes on Eilean Bulgach, Sutherland. *Scottish Naturalist,* **1950**: 26-30.
Class: Mamm Bird
Area: NW

4403 **Allan, R.M.** (1950). Fleas (*Siphonaptera*) from birds in north-east Scotland. *Scottish Naturalist,* **1950**: 33-41.
Class: Bird
Area: Gen DE

4404 **Dunnet, G.M.** (1950). Fleas (*Siphonaptera*) from mammals in Aberdeenshire. *Scottish Naturalist,* **1950**: 42-49.
Class: Mamm
Area: Gen DE

4405 **Thomas, H.J.** (1950). Fries' Goby in Ross-shire and in Argyllshire. *Scottish Naturalist,* **1950**: 53-54.
Class: Fish
Area: NW AG

4406 **Hewson, R.** (1950). Common and Pigmy Shrews occurring together. *Scottish Naturalist,* **1950**: 54.
Class: Mamm
Area: Gen MO

4407 **Dunnet, G.M.** (1950). Common and Pigmy Shrews occurring together. *Scottish Naturalist,* **1950**: 54.
Class: Mamm
Area: Gen MO

4408 **Pennie, I.D.** (1950). The Tongue Badgers. *Scottish Naturalist,* **1950**: 54-55.
Class: Mamm
Area: CS

4409 **Meinertzhagen, R.** (1950). Tree-Creeper in Harris. *Scottish Naturalist,* **1950**: 55.
Class: Bird
Area: OH

4410 **Editorial note.** (1950). [Northern Tree-Creeper - first record for Outer Hebrides]. *Scottish Naturalist,* **1950**: 55.
Class: Bird
Area: OH

4411 **Campbell, J.W.** (1950). Chiffchaff in north Perth. *Scottish Naturalist,* **1950**: 55.
Class: Bird
Area: TA

4412 **Pennie, I.D.** (1950). The Sylviidae in north Sutherland. *Scottish Naturalist,* **1950**: 55-56.
Class: Bird
Area: CS

4413 **Clancey, P.A.** (1950). The scarcity of wintering Redwings and Fieldfares in south-west Scotland in 1949-50. *Scottish Naturalist,* **1950**: 56.
Class: Bird
Area: Gen CL

4414 **Editorial note.** (1950). Winter status of Redwings and Fieldfares in Scotland. *Scottish Naturalist,* **1950**: 56.
Class: Bird
Area: Gen FO TA MO NW

4415 **Baxter, E.V.** (1950). House Martins settling on Ash trees. *Scottish Naturalist,* **1950**: 56-57.
Class: Bird
Area: Gen FO

4416 **Anderson, D.R.** (1950). Buzzard in East Lothian. *Scottish Naturalist,* **1950**: 57.
Class: Bird
Area: FO

4417 **Campbell, J.W.** (1950). The breeding of the Heron in the Outer Hebrides. *Scottish Naturalist,* **1950**: 57.
Class: Bird
Area: OH

4418 **Arthur, G.** (1950). Steller's Eider in Orkney. *Scottish Naturalist,* **1950**: 57-58.
Class: Bird
Area: OR

4419 **Pennie, I.D.** (1950). Reflex actions as forms of distraction display. *Scottish Naturalist,* **1950**: 58-59.
Class: Mamm Bird
Area: Gen

4420 **Editorial note.** (1950). Reflex actions as forms of distraction display. *Scottish Naturalist,* **1950**: 59.
Class: Bird
Area: Gen

4421 **Maw, M.C. and Andrew, D.G.** (1950). Wader migration in Midlothian. *Scottish Naturalist,* **1950**: 59.
Class: Bird
Area: FO

4422 **Hayes, R.E.** (1950). Black-tailed Godwit in north Perth. *Scottish Naturalist,* **1950**: 59-60.
Class: Bird
Area: TA

4423 **Editorial note.** (1950). [Black-tailed Godwit in north Perth]. *Scottish Naturalist,* **1950**: 60.
Class: Bird
Area: Gen

4424 **Gordon, S.** (1950). Black-tailed Godwit in Skye. *Scottish Naturalist,* **1950**: 60.
Class: Bird
Area: IH

4425 **Editorial note.** (1950). [First record of Black-tailed Godwit for Skye]. *Scottish Naturalist,* **1950**: 60.
Class: Bird
Area: IH

4426 **Fitter, R.S.R.** (1950). Sanderling and Bar-tailed Godwit in Sutherland. *Scottish Naturalist,* **1950**: 60.
Class: Bird
Area: NW

4427 **Boase, H.** (1950). Passage birds at Lintrathen Reservoir. *Scottish Naturalist,* **1950**: 60.
Class: Bird
Area: TA

4428 **Nelson, S.** (1950). "Injury-feigning" of Oyster-catcher. *Scottish Naturalist,* **1950**: 60-61.
Class: Bird
Area: Gen CL

4429 **Williamson, K.** (1950). Distraction behaviour of the Oyster-catcher. *Scottish Naturalist,* **1950**: 61-63.
Class: Bird
Area: Gen

4430 **Cramp, S.** (1950). Chick survival in the Kittiwake. *Scottish Naturalist,* **1950**: 63-64.
Class: Bird
Area: Gen FO

4431 **Pennie, I.D.** (1950-51). The history and distribution of the Capercaillie in Scotland. *Scottish Naturalist,* **1950**: 65-87, 157-178; **1951**: 4-17.
Class: Bird
Area: Gen SO TW CL FO DE MO CS NW AG

4432 **Brian, M.V. and Brian, A.D.** (1950). Bird predation of defoliating caterpillars. *Scottish Naturalist,* **1950**: 88-92.
Class: Bird
Area: Gen CL

4433 **Rintoul, L.J. and Baxter, E.V.** (1950). Natural history notes from the Isle of Gigha. *Scottish Naturalist,* **1950**: 93-97.
Class: Mamm Bird
Area: IH

4434 **Elder, H.F.D** (1950). Isle of May Bird Observatory and Field Station. Bird report, 1948 and 1949. *Scottish Naturalist,* **1950**: 98-108.
Class: Bird
Area: FO

4435 **Duffey, E.** (1950). Non-breeding in the Fulmar *Fulmarus glacialis*. *Scottish Naturalist,* **1950**: 111-121.
Class: Bird
Area: Gen FI

4436 **Blackwood, R.C.** (1950). Hawfinch in East Lothian. *Scottish Naturalist,* **1950**: 124.
Class: Bird
Area: FO

4437 **Douglas-Home, H.** (1950). Pied Flycatchers in Leet valley, Coldstream. *Scottish Naturalist,* **1950**: 124-125.
Class: Bird
Area: TW

4438 **Campbell, J.W.** (1950). Chiffchaff in east Inverness. *Scottish Naturalist,* **1950**: 125.
Class: Bird
Area: MO

4439 **Campbell, J.W.** (1950). Blackcap in east Ross. *Scottish Naturalist,* **1950**: 125.
Class: Bird
Area: MO

4440 **Thin, R.G.** (1950). Stonechats in Midlothian. *Scottish Naturalist,* **1950**: 125.
Class: Bird
Area: FO

4441 **Douglas-Home, H.** (1950). Little Owls in Berwickshire. *Scottish Naturalist,* **1950**: 125-126.
Class: Bird
Area: TW

4442 **Editorial note.** (1950). [Possible breeding of Little Owls in Scotland]. *Scottish Naturalist,* **1950**: 126.
Class: Bird
Area: Gen

4443 **Richter, R.** (1950). Hen Harriers *Circus cyaneus* in Moray. *Scottish Naturalist,* **1950**: 126.
Class: Bird
Area: MO

4444 **Home, W.M.L.** (1950). Barnacle Geese in Berwickshire. *Scottish Naturalist,* **1950**: 126-127.
Class: Bird
Area: TW

4445 **Boase, H.** (1950). A further note on the display of Velvet Scoter. *Scottish Naturalist,* **1950**: 127-128.
Class: Bird
Area: Gen TA

4446 **Clancey, P.A.** (1950). Turtle Dove and Little Auk in north Perth. *Scottish Naturalist,* **1950**: 128.
Class: Bird
Area: TA

4447 **Editorial note.** (1950). [Turtle Dove and Little Auk in north Perth]. *Scottish Naturalist,* **1950**: 128.
Class: Bird
Area: TA

4448 **Weir, R.S.** (1950). Black Guillemot at Gullane, East Lothian. *Scottish Naturalist,* **1950**: 128.
Class: Bird
Area: FO

4449 **Orkin, P.A.** (1950). A history of the Opah *Lampris guttatus* (Brünnich). *Scottish Naturalist,* **1950**: 129-141.
Class: Fish
Area: Gen FO DE

4450 **Venables, L.S.V. and Venables, U.M.** (1950). The Whooper Swans of Loch Spiggie, Shetland. *Scottish Naturalist,* **1950**: 142-152.
Class: Bird
Area: SH

4451 **Steven, D.** (1950). Note on a school of Pilot Whales stranded in East Lothian. *Scottish Naturalist,* **1950**: 153-156.
Class: Mamm
Area: FO

4452 **Halliday, H.** (1950). Courtship feeding of Carrion Crow. *Scottish Naturalist,* **1950**: 179.
Class: Bird
Area: Gen FO

4453 **Hay, I.** (1950). Pied Flycatcher in Midlothian. *Scottish Naturalist,* **1950**: 180.
Class: Bird
Area: FO

4454 **Campbell, B.** (1950). Pied Flycatcher in Argyll. *Scottish Naturalist,* **1950**: 180.
Class: Bird
Area: AG

4455 **Mackenzie, J.M.D.** (1950). Pied Flycatcher nesting in Perthshire. *Scottish Naturalist,* **1950**: 180-181.
Class: Bird
Area: TA

4456 **Editorial note** (1950). Extension of nesting range of Pied Flycatcher. *Scottish Naturalist,* **1950**: 181-182.
Class: Bird
Area: Gen FO TA MO AG

4457 **Hunter, E.M.** (1950). Osprey in Morayshire. *Scottish Naturalist,* **1950**: 182-183.
Class: Bird
Area: MO

4458 **Hamilton, F.D., Smith, R.J.W. and Walker, C.** (1950). Garganey in Outer Hebrides. *Scottish Naturalist,* **1950**: 183.
Class: Bird
Area: OH

4459 **Perry, R.** (1950). Wood Sandpiper in east Inverness-shire. *Scottish Naturalist,* **1950**: 183.
Class: Bird
Area: MO

4460 **Editorial note.** (1950). [Wood Sandpiper in east Inverness-shire]. *Scottish Naturalist,* **1950**: 183.
Class: Bird
Area: MO

4461 **Swan, M.** (1950). Dotterel in Wester Ross. *Scottish Naturalist,* **1950**: 184.
Class: Bird
Area: NW

4462 **Editorial note.** (1950). [Dotterel formerly breeding in Wester Ross]. *Scottish Naturalist,* **1950**: 184.
Class: Bird
Area: NW

4463 **Goodwin, D.** (1950). White Oyster-catcher on Handa Island. *Scottish Naturalist,* **1950**: 184.
Class: Bird
Area: NW

4464 **Stevenson, S.D.** (1950). Early arrival of Sandwich Tern on Ayrshire coast. *Scottish Naturalist,* **1950**: 184.
Class: Bird
Area: CL

4465 **Whipp, J.M.P.** (1950). A high Black-headed Gull's colony. *Scottish Naturalist,* **1950**: 184-185.
Class: Bird
Area: Gen SO

4466 **Editorial comment**. (1950). [High Black-headed Gull colony]. *Scottish Naturalist,* **1950**: 185.
Class: Bird
Area: Gen

4467 **Platt, M.I.** (1950). Unusual records as exemplified by bone relics. *Scottish Naturalist,* **1950**: 185-186.
Class: Bird
Area: Gen

4468 **Hamilton, F.D. and Macgregor, K.S.** (1950). Barnacle Geese in East Lothian. *Scottish Naturalist,* **1950**: 186.
Class: Bird
Area: FO

4469 **Wynne-Edwards, V.C.** (1950). Pheasant x Capercaillie hybrid. *Scottish Naturalist,* **1950**: 186-187.
Class: Bird
Area: Gen MO

MAMMALS

SCOTLAND - GENERAL

3060 3061 3105 3117 3143 3151 3162 3172 3180 3196 3197 3224
3256 3258 3270 3275 3305 3306 3312 3326 3345 3364 3365 3372
3388 3414 3434 3453 3474 3503 3504 3544 3547 3557 3577 3588
3680 3685 3689 3743 3744 3757 3760 3761 3762 3787 3788 3793
3816 3843 3867 3871 3887 3903 3906 3912 3928 3939 3947 3957
3965 3975 3988 3990 4019 4086 4098 4119 4177 4192 4195 4201
4212 4238 4274 4282 4316 4321 4365 4404 4406 4407 4419

SOLWAY

3341 3368 3416 3439 3481 3485 3588 3656 3657 3660 3680 3712
3760 3762 3775 3788 3887 3939 3943 4019

TWEED

3168 3343 3372 3439 3788 4177 4316

CLYDE

3144 3179 3184 3293 3414 3439 3577 3594 3743 3760 3762 3788
3817 3845 3883 3901 3975 3976 3984 4119 4127 4145

FORTH

3053 3064 3094 3119 3196 3197 3259 3260 3305 3323 3439 3516
3566 3577 3679 3712 3714 3743 3757 3781 3783 3788 3817 3818
3876 3958 3965 4057 4451

TAY

3042 3051 3091 3251 3254 3256 3276 3345 3367 3432 3475 3544
3588 3691 3712 3743 3757 3788 3876 3912 3928 3964 3965 4056
4057 4195 4365 4366 4367

DEE

3051 3371 3414 3435 3588 3689 3712 3788 3804 3937 4057 4274
4316 4404

MORAY

3051 3211 3229 3258 3323 3414 3415 3690 3712 3788 3816 3927
3928 3938 4057 4145 4327 4406 4407

CAITHNESS AND SUTHERLAND

3051 3063 3161 3197 3211 3229 3345 3414 3788 3928 4057 4408

NORTH-WEST HIGHLANDS
3157 3274 3788 3802 3928 3957 3990 4141 4341 4402

ARGYLL
3252 3640 3788 3816 3883 3901 3928 3947 3990

INNER HEBRIDES
3066 3641 3673 3678 3680 3788 3793 3837 3846 4006 4034 4151
4182 4433

OUTER HEBRIDES
3277 3579 3645 3714 3787 3788 3803 3842 3867 3990 4002 4102
4205

ST. KILDA
3489 4122

OUTLIERS
4122 4141

ORKNEY
3414 3523 3594 3597 3598 3655 3712 3731 3802 3827 3828 3836
4107 4145

SHETLAND
3104 3105 3180 3312 3343 3414 3712 3757 3963 4098 4121

FAIR ISLE
3783

BIRDS

SCOTLAND - GENERAL

3044 3046 3052 3057 3059 3060 3062 3065 3067 3069 3070 3071
3076 3080 3086 3087 3092 3093 3098 3101 3102 3108 3116 3117
3121 3124 3125 3135 3138 3139 3149 3151 3152 3155 3163 3167
3176 3182 3187 3189 3198 3202 3203 3212 3234 3239 3242 3243
3245 3247 3255 3256 3265 3270 3271 3272 3278 3279 3280 3281
3285 3304 3321 3326 3328 3331 3334 3335 3339 3357 3362 3363
3372 3382 3386 3389 3392 3398 3401 3405 3408 3409 3417 3433
3437 3438 3447 3449 3450 3452 3453 3459 3462 3480 3490 3495
3497 3498 3503 3504 3508 3509 3510 3520 3521 3532 3540 3541
3544 3545 3547 3548 3551 3565 3567 3570 3581 3583 3586 3589
3596 3600 3608 3609 3613 3618 3620 3621 3653 3674 3677 3688
3693 3694 3696 3697 3699 3700 3701 3704 3710 3716 3717 3722
3723 3729 3736 3746 3748 3751 3753 3754 3755 3786 3789 3795
3808 3814 3820 3821 3834 3838 3839 3840 3850 3851 3854 3871
3878 3898 3899 3900 3907 3915 3919 3920 3921 3925 3930 3934
3935 3940 3944 3945 3948 3952 3956 3957 3973 3996 3998 4003
4004 4013 4014 4023 4024 4029 4033 4043 4054 4055 4058 4061
4062 4073 4080 4093 4094 4095 4105 4109 4110 4118 4134 4135
4144 4146 4156 4157 4162 4163 4164 4175 4176 4178 4185 4191
4198 4201 4202 4212 4214 4215 4216 4219 4220 4228 4229 4230
4236 4237 4238 4240 4241 4242 4243 4246 4249 4250 4252 4255
4258 4259 4260 4261 4264 4265 4267 4272 4273 4276 4278 4279
4282 4283 4292 4293 4296 4303 4305 4309 4314 4315 4316 4317
4318 4320 4329 4331 4332 4343 4348 4351 4353 4364 4368 4369
4371 4377 4378 4379 4382 4383 4388 4392 4393 4394 4398 4399
4400 4403 4413 4414 4415 4419 4420 4423 4428 4429 4430 4431
4432 4435 4442 4445 4452 4456 4465 4466 4467 4469

SOLWAY

3062 3084 3106 3109 3139 3158 3166 3174 3199 3213 3225 3241
3243 3247 3281 3292 3296 3325 3327 3329 3335 3348 3369 3402
3410 3438 3466 3482 3497 3562 3564 3572 3573 3587 3591 3631
3633 3636 3646 3659 3660 3661 3674 3687 3688 3699 3704 3735
3746 3751 3754 3768 3784 3814 3819 3830 3879 3899 3907 3940
3943 3956 3966 3977 4016 4024 4055 4070 4095 4105 4113 4163
4165 4169 4176 4216 4278 4279 4343 4431 4465

TWEED

3084 3099 3109 3115 3139 3187 3193 3199 3232 3287 3292 3304
3330 3348 3372 3380 3394 3409 3410 3427 3440 3457 3462 3466
3468 3492 3493 3505 3506 3507 3527 3528 3537 3538 3546 3549
3550 3558 3562 3568 3587 3646 3658 3662 3682 3683 3684 3686

3830 3868 3881 3961 3966 3982 4046 4055 4095 4105 4136 4139
4163 4193 4216 4278 4279 4284 4285 4316 4431 4437 4441 4444

CLYDE

3049 3072 3075 3077 3084 3092 3097 3109 3111 3132 3135 3138
3139 3140 3144 3146 3147 3163 3181 3182 3199 3200 3203 3206
3207 3216 3218 3221 3225 3235 3239 3257 3263 3264 3282 3283
3286 3291 3292 3307 3308 3322 3336 3348 3370 3379 3381 3384
3385 3386 3389 3405 3410 3460 3466 3500 3524 3554 3555 3562
3564 3569 3570 3574 3587 3590 3610 3611 3612 3624 3631 3633
3643 3646 3672 3702 3703 3704 3705 3723 3726 3730 3752 3763
3798 3799 3805 3806 3807 3811 3812 3813 3830 3831 3850 3853
3861 3881 3892 3929 3930 3933 3935 3962 3966 3973 3974 3979
3980 3982 3984 3985 3987 4005 4031 4036 4044 4047 4052 4055
4076 4077 4078 4085 4088 4095 4100 4103 4105 4106 4116 4124
4126 4128 4129 4131 4137 4160 4163 4166 4171 4173 4176 4178
4181 4185 4188 4196 4197 4199 4200 4208 4210 4211 4216 4228
4278 4279 4296 4309 4313 4334 4335 4339 4346 4352 4353 4364
4372 4384 4385 4386 4387 4389 4390 4394 4413 4428 4431 4432
4464

FORTH

3047 3053 3054 3058 3067 3076 3081 3084 3095 3096 3109 3112
3128 3129 3133 3138 3139 3141 3154 3164 3169 3170 3171 3173
3186 3199 3225 3227 3228 3236 3238 3239 3242 3244 3245 3246
3250 3253 3261 3266 3267 3268 3269 3273 3278 3279 3284 3285
3288 3292 3294 3295 3302 3303 3314 3315 3320 3321 3331 3332
3340 3348 3350 3352 3353 3356 3359 3360 3361 3362 3373 3375
3376 3378 3391 3395 3396 3399 3400 3401 3403 3408 3410 3412
3423 3424 3426 3437 3446 3447 3448 3451 3452 3458 3465 3466
3467 3470 3472 3477 3478 3495 3499 3509 3514 3515 3518 3520
3521 3531 3533 3534 3536 3548 3556 3559 3560 3561 3562 3570
3571 3575 3576 3582 3587 3595 3599 3604 3608 3613 3616 3622
3623 3626 3627 3628 3629 3630 3631 3634 3646 3652 3666 3667
3674 3692 3697 3698 3700 3704 3706 3707 3709 3711 3713 3714
3715 3722 3724 3725 3727 3729 3732 3736 3737 3738 3739 3740
3741 3745 3747 3749 3750 3752 3753 3759 3764 3765 3777 3778
3779 3782 3786 3789 3790 3795 3800 3801 3820 3822 3823 3825
3829 3830 3834 3835 3852 3859 3863 3869 3870 3872 3873 3876
3877 3881 3884 3889 3890 3891 3894 3900 3904 3913 3916 3920
3923 3945 3946 3948 3950 3953 3954 3960 3961 3966 3969 3970
3972 3981 3983 3993 3998 3999 4001 4005 4007 4015 4017 4022
4025 4027 4028 4029 4030 4032 4036 4038 4042 4045 4049 4051
4053 4055 4058 4059 4060 4062 4063 4064 4065 4066 4067 4068
4069 4071 4079 4080 4081 4082 4087 4092 4095 4096 4097 4101
4104 4105 4108 4115 4120 4135 4146 4147 4152 4154 4156 4163
4164 4168 4170 4172 4174 4176 4179 4180 4183 4186 4187 4189

4194 4207 4209 4216 4217 4223 4224 4234 4235 4240 4246 4247
4248 4252 4270 4271 4272 4278 4279 4280 4281 4290 4291 4292
4294 4295 4298 4299 4303 4310 4311 4312 4313 4323 4328 4329
4330 4342 4343 4344 4345 4347 4348 4349 4356 4357 4359 4360
4362 4377 4391 4396 4397 4414 4415 4416 4421 4430 4431 4434
4436 4440 4448 4452 4453 4456 4468

TAY
3042 3050 3057 3062 3068 3073 3084 3087 3108 3122 3126 3128
3139 3145 3149 3153 3175 3199 3203 3205 3215 3219 3220 3231
3239 3240 3251 3256 3292 3309 3313 3325 3328 3347 3348 3355
3358 3363 3366 3392 3410 3433 3449 3466 3471 3472 3473 3476
3479 3484 3498 3513 3522 3526 3544 3549 3562 3565 3580 3587
3600 3607 3617 3621 3622 3631 3632 3646 3653 3663 3681 3694
3704 3721 3725 3752 3821 3830 3847 3851 3854 3876 3881 3896
3915 3949 3961 3966 3972 3978 4000 4005 4035 4050 4055 4075
4089 4091 4094 4095 4101 4105 4109 4110 4114 4117 4138 4149
4153 4159 4163 4167 4176 4216 4225 4236 4240 4241 4242 4251
4262 4278 4279 4286 4287 4288 4289 4293 4306 4312 4318 4333
4350 4368 4369 4370 4371 4379 4395 4400 4411 4414 4422 4427
4445 4446 4447 4455 4456

DEE
3084 3109 3139 3199 3239 3292 3348 3407 3408 3410 3444 3457
3466 3562 3605 3615 3619 3620 3625 3646 3654 3662 3668 3669
3674 3677 3704 3752 3830 3878 3908 3986 3992 4005 4037 4055
4095 4105 4130 4157 4163 4176 4184 4216 4218 4258 4259 4260
4278 4279 4309 4316 4374 4388 4403 4431

MORAY
3062 3084 3113 3139 3167 3187 3192 3199 3217 3280 3292 3348
3349 3390 3410 3429 3442 3466 3535 3562 3564 3567 3585 3587
3609 3625 3646 3662 3675 3715 3752 3769 3770 3780 3830 3881
3886 3893 3919 3921 3936 3961 3966 3996 4005 4055 4095 4099
4105 4123 4125 4158 4163 4176 4216 4218 4233 4245 4276 4278
4279 4304 4305 4309 4340 4375 4414 4431 4438 4439 4443 4456
4457 4459 4460 4469

CAITHNESS AND SUTHERLAND
3070 3071 3084 3088 3089 3098 3103 3128 3134 3139 3187 3191
3194 3198 3199 3203 3208 3214 3292 3324 3348 3393 3404 3410
3442 3463 3466 3562 3564 3587 3614 3631 3646 3651 3676 3704
3725 3752 3860 3880 3881 3882 3898 3914 3917 3926 3931 3936
3955 3961 3966 3989 3995 4005 4011 4055 4095 4105 4111 4163
4176 4216 4231 4232 4237 4267 4278 4279 4302 4338 4358 4381
4412 4431

NORTH-WEST HIGHLANDS

3057 3084 3090 3108 3124 3139 3199 3292 3348 3404 3410 3466
3469 3473 3539 3562 3564 3587 3631 3646 3704 3791 3794 3796
3797 3809 3830 3885 3914 3924 3926 3957 3966 4055 4085 4095
4105 4141 4163 4176 4216 4249 4250 4253 4254 4255 4263 4264
4266 4268 4269 4273 4278 4279 4301 4302 4308 4332 4336 4337
4341 4354 4355 4361 4373 4376 4380 4402 4414 4426 4431 4461
4462 4463

ARGYLL

3084 3139 3148 3199 3292 3348 3381 3410 3425 3466 3472 3562
3564 3587 3624 3631 3646 3704 3752 3886 3997 4005 4036 4055
4076 4085 4095 4105 4155 4163 4176 4190 4216 4278 4279 4300
4305 4339 4375 4431 4454 4456

INNER HEBRIDES

3074 3084 3107 3111 3139 3142 3148 3156 3199 3203 3204 3234
3237 3292 3297 3300 3348 3377 3383 3410 3413 3428 3466 3491
3494 3562 3563 3564 3587 3631 3638 3639 3644 3646 3704 3708
3815 3846 3866 3875 3897 3966 4005 4020 4026 4084 4090 4095
4110 4140 4150 4151 4163 4176 4190 4216 4278 4279 4297 4305
4307 4378 4424 4425 4433

OUTER HEBRIDES

3062 3084 3128 3150 3187 3190 3199 3203 3209 3292 3348 3408
3410 3443 3466 3530 3562 3564 3631 3646 3647 3648 3664 3665
3670 3671 3676 3693 3714 3720 3728 3733 3734 3752 3758 3773
3785 3824 3830 3832 3855 3862 3864 3865 3874 3881 3911 3959
3966 4002 4005 4021 4072 4083 4085 4095 4148 4163 4176 4216
4267 4278 4279 4322 4409 4410 4417 4458

ST. KILDA

3084 3199 3292 3410 3417 3489 3529 3562 3637 3826 3942 4122
4163 4216

OUTLIERS

3084 3199 3292 3410 3417 3564 3592 3593 3631 3704 3844 4009
4122 4141 4176 4216

ORKNEY

3084 3100 3101 3128 3199 3201 3202 3233 3248 3255 3292 3348
3351 3410 3441 3464 3466 3510 3564 3631 3695 3704 3718 3719
3752 3771 3772 3774 3830 3833 3841 3849 3881 3888 3944 3961
3966 4010 4018 4095 4112 4142 4143 4163 4176 4206 4216 4256
4257 4267 4278 4343 4418

SHETLAND

3055	3056	3082	3083	3084	3114	3123	3128	3130	3131	3187	3188
3199	3292	3316	3317	3346	3408	3410	3418	3420	3421	3422	3436
3437	3445	3461	3462	3466	3486	3487	3488	3511	3517	3562	3601
3602	3631	3646	3776	3792	3839	3881	3909	3910	3917	3961	3966
4012	4018	4039	4055	4095	4163	4213	4214	4216	4227	4243	4277
4279	4309	4314	4450								

FAIR ISLE

3043	3045	3048	3084	3086	3113	3114	3120	3121	3160	3183	3199
3203	3210	3230	3239	3292	3310	3311	3316	3318	3319	3333	3344
3348	3397	3398	3410	3417	3418	3419	3430	3431	3454	3455	3456
3457	3462	3466	3483	3501	3502	3512	3542	3543	3552	3553	3562
3584	3635	3649	3650	3752	3951	3961	3966	4005	4040	4048	4055
4095	4163	4226	4240	4275	4309	4319	4363	4401	4435		

REPTILES

SCOTLAND - GENERAL
3151 3177 3226 3270 4212 4324

SOLWAY
4324

TWEED
Nil

CLYDE
4324

FORTH
Nil

TAY
Nil

DEE
Nil

MORAY
3223 4324

CAITHNESS AND SUTHERLAND
Nil

NORTH-WEST HIGHLANDS
3177 3902

ARGYLL
Nil

INNER HEBRIDES
4034 4182

OUTER HEBRIDES
3918 4002

ST. KILDA
Nil

OUTLIERS
Nil

ORKNEY
Nil

SHETLAND
4324

FAIR ISLE
Nil

AMPHIBIANS

SCOTLAND - GENERAL
3070 3071 3270 4212 4324

SOLWAY
4324

TWEED
Nil

CLYDE
4324

FORTH
Nil

TAY
Nil

DEE
Nil

MORAY
4324

CAITHNESS AND SUTHERLAND
3070 3071 3089 3222

NORTH-WEST HIGHLANDS
3902

ARGYLL
Nil

INNER HEBRIDES
4034

OUTER HEBRIDES
Nil

ST. KILDA
Nil

OUTLIERS
Nil

ORKNEY
Nil

SHETLAND
4324

FAIR ISLE
Nil

FISHES

SCOTLAND - GENERAL
3079 3085 3118 3165 3185 3195 3249 3262 2370 3290 3299 3337
3374 3387 3519 3525 3606 3767 3895 3968 4074 4192 4203 4212
4222 4239 4449

SOLWAY
3137 3178 3290 3298 3299 3496 3856 3918

TWEED
4221

CLYDE
3085 3110 3118 3338 3406 3603 3742 3848 3895 3918

FORTH
3127 3165 3249 3354 3766 3767 3810 3876 3895 3918 3922 3941
3994 4041 4325 4326 4449

TAY
3127 3136 3290 3301 3767 3876 3895 3905 4133 4203 4244

DEE
3249 3354 3578 3642 3858 3895 3967 3991 4008 4161 4239 4449

MORAY
3374 3387 3411 3895 3932 3991 4008 4204 4222 4244

CAITHNESS AND SUTHERLAND
Nil

NORTH-WEST HIGHLANDS
3159 3756 3857 4405

ARGYLL
3127 3338 4405

INNER HEBRIDES
3078 3159 3756 3846 3918

OUTER HEBRIDES
3971

ST. KILDA
3895

OUTLIERS
4132

ORKNEY
3742 4132

SHETLAND
3289 3895

FAIR ISLE
Nil

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PERSECUTION OF RED SQUIRRELS BY THE HIGHLAND SQUIRREL CLUB, 1903-1946

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Abstract: The Ross-shire Squirrel Club was established in 1903 to control the numbers of Red Squirrels *Sciurus vulgaris* in Ross-shire. The Club extended its area to cover adjacent Inverness-shire in 1905 and Sutherland in 1906, and in 1907 was re-named the Highland Squirrel Club. The Annual Reports and correspondence relating to the Club were investigated to study variations in the numbers of squirrels killed. The numbers of squirrels submitted per square kilometre of woodland varied between different areas, and there were different patterns of decline in the numbers of squirrels submitted with time. Declines were not due to loss of woodlands or changes in persecution. The workings and economics of the Club were examined.

Introduction

This paper examines changes in the numbers of Red Squirrels submitted for bonus payment to the Highland Squirrel Club. It is assumed that the numbers of animals submitted provide an index of population changes. This assumption lies behind many important studies of population changes which are based on trapping and hunting records (e.g. Hewson, 1984; Hudson, 1992; Tapper, 1992), although there is usually no direct evidence of this. A relationship, however, between numbers of animals killed and an independent measure of population size (scat counts) has previously been established for the Fox *Vulpes vulpes* (Kolb and Hewson, 1980). It is appreciated that variations in trapping effort may exist and so may affect the numbers of animals submitted (see McDonald and Harris, 1999).

The Ross-shire Squirrel Club was established in 1903 following a meeting of the major East Ross landowners in 1902. The aim of the Club was to reduce the numbers of Red Squirrels, which were causing commercial damage to estate plantations. The rationale of the Club was that persecution had to be systematic throughout a district to have any hope of controlling numbers (Fraser, 1907). The Club increased its area in 1905 to control squirrels in East Inverness-shire, and in

Sutherland from 1906, and changed its name to the Highland Squirrel Club in 1907 (Figure 1; Table 1); it last operated in 1946. There is no published detailed analysis of the full activities of the Highland Squirrel Club. The yearly returns for 1903-1917 were cited by Ritchie (1920) and quoted by Anderson (1967). Information was passed from the Squirrel Club to the Oxford University Rodent Enquiry of 1929, and Middleton (1930) commented on the widely fluctuating numbers killed on three estates (Beaufort, Novar and Ardross) and postulated the existence of population cycles. Middleton's reference to "well over 82,000" killed between 1903 and 1929 was quoted by Shorten (1954) and Laidler (1980). Hewson (1953) studied the total number of squirrels killed by the Club between 1903 and 1946 and on Ardross Estate in particular.

Papers relating to the Highland Squirrel Club were found amongst the papers of Duncan and Duncan, a Dingwall (Ross-shire) firm of lawyers, which had been deposited in the Highland Regional Council Archive in February 1999 (Highland Regional Council Archive reference number HCA/D522). This information about the Squirrel Club had remained unknown for many years, but was rediscovered following extensive searches by RVC. The bulk of the archive consists of Annual Reports of the activities of the Squirrel Club for 1903-46, minutes of Annual General Meetings for 1919-46, letters to the Secretary of the Club during 1909-10, 1918-26 and 1929-37, plus receipts and cheque stubs for bonus payments. Annual Reports, A.G.M. minutes, and correspondence were analysed by HAM, to examine changes in the numbers of squirrels killed and to piece together the history of the Club; the archive also offered a rare opportunity to examine the economics of persecution in the early 20th century. The order of authorship of this paper was established alphabetically. A distribution map was plotted using the program 'DMAP' (designed by Dr. A Morton).

History of the Red Squirrel in North Scotland

The Red Squirrel was widespread in Scotland north of the Forth and the Clyde during the 17th century. Populations were reduced in the 18th century almost to the point of extinction, largely due to deforestation (Harvie-Brown, 1881a; Ritchie, 1920). Introductions were made to ten Scottish estates in the 18th and 19th centuries, probably for ornamental reasons; animals for these introductions mainly came from England (Lowe and Gardiner, 1983). The Grey Squirrel *Sciurus carolinensis* was never introduced in north Scotland and has not been found in Highland Region (Lloyd, 1983); all squirrels killed by the Club were therefore assumed to have been Red Squirrels although they were invariably referred to as 'squirrels'. In the northern Highlands, Lady Lovat introduced Red Squirrels to

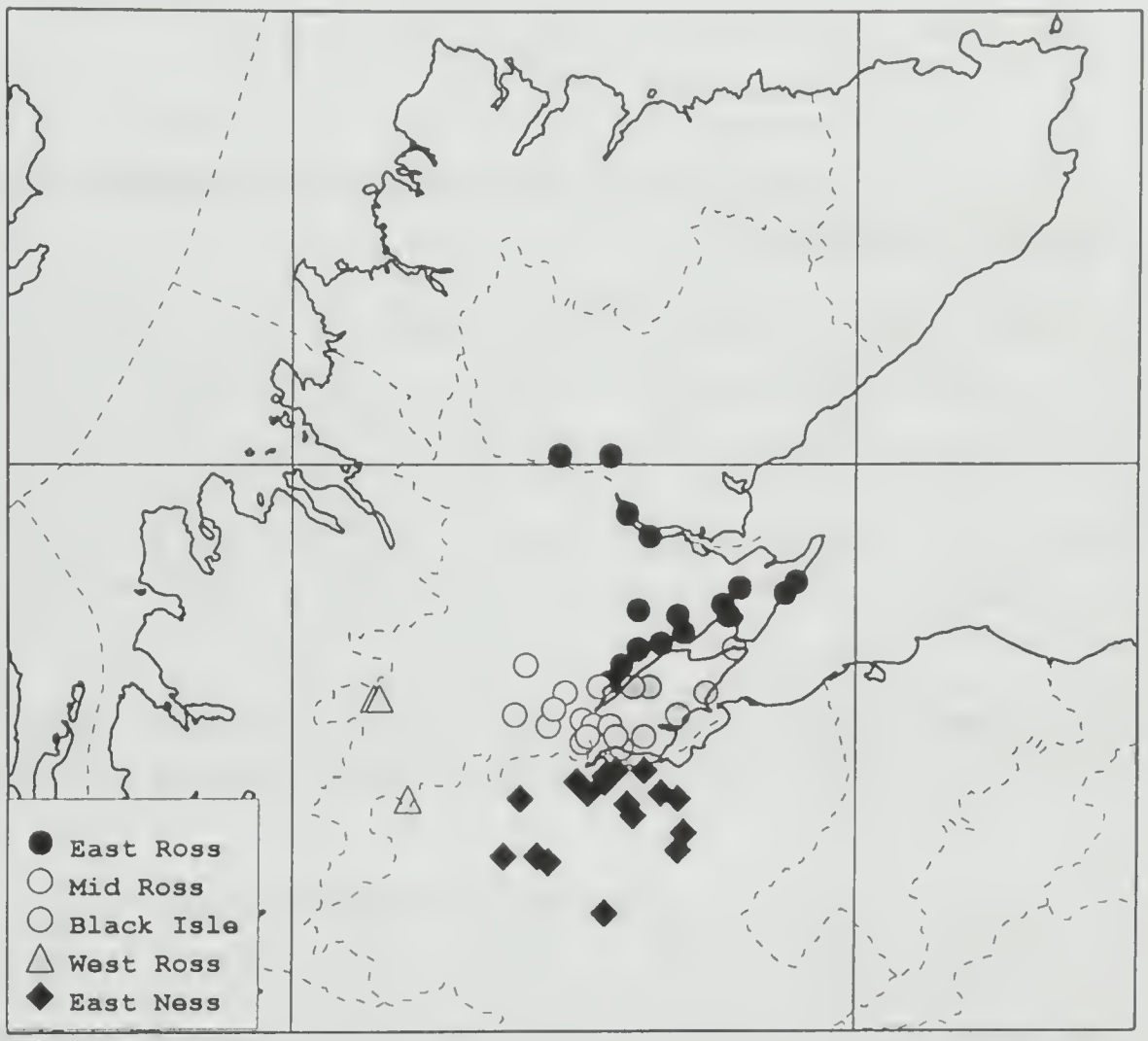

Figure 1

Map of North Scotland
showing Distribution of Members of Highland Squirrel Club
and Vice-County Boundaries

Table 1. Changes in membership and numbers of squirrels submitted to the Highland Squirrel Club 1903-46

	1903 -08	**1909 -13**	**1914 -18**	**1919 -24**	**1925 -29**	**1930 -34**	**1935 -39**	**1940 -46**
Mean (& SD) no. of subscribers per year	41.5 (5.5)	43.2 (1.1)	41.6 (0.6)	38.0 (1.3)	38.0 (0.7)	35.6 (1.5)	32.0 (1.4)	24.3 (2.5)
Mean (& SD) area of woodland covered per year (km^2)	185.5 (23.9)	189.3 (6.8)	179.7 (2.2)	169.6 (6.2)	163.5 (6.5)	143.7 (7.2)	121.8 (11.9)	82.5 (15.8)
Mean (& SD) no. of squirrels submitted per year	4,329.7 (1,245.1)	4,290.4 (1,686.4)	3,180.2 (670.1)	2,170.8 (627.0)	1,949.6 (294.3)	2,216.8 (476.6)	1,044.2 (933.3)	70.1 (22.8)
Max. no. of squirrels submitted per year[1]	6,628 (1907)	7,199 (1909)	3,998 (1917)	3,201 (1922)	2,429 (1928)	2,658 (1933)	2,254 (1936)	107 (1940)
Total no. of squirrels submitted	25,978	21,452	15,901	13,025	9,748	11,084	5,221	491

1. Year in brackets.

Beaufort Castle near Beauly, Inverness-shire, in 1844 (Harvie-Brown, 1881b; Ritchie, 1920). The species spread rapidly in estate forests, which were mainly planted in the second half of the nineteenth century (Anderson, 1967); this spread was probably assisted by the low numbers of predators, which had been vastlly reduced by human persecution (Ritchie, 1920 and 1931).

Red Squirrels were first recorded in Ross-shire in 1858, when many estate plantations would have been at least twenty years old and presented suitable habitat for squirrels. Red Squirrels were recorded north to the Dornoch Firth in 1859, and the species had also spread east through Morayshire and south along the Great Glen; it even reached West Ross in 1893 (Harvie-Brown, 1881b; Ritchie, 1920). Squirrels were well distributed throughout woodlands in Ross, Ness, and East Sutherland in the early 20th century (Darling, 1947). It is possible that native Red Squirrels persisted in plantations and remnant forests in north-east Ross and south Sutherland throughout the 18th and 19th centuries, and that squirrels spread from there as well as from Beaufort, since some early squirrel records were surprisingly far from Beaufort (Hewson, 1953; Anderson, 1967). Native Red Squirrels did not become extinct in Strathspey (Forsyth, 1900).

Damage to Woodlands caused by Squirrels

The Red Squirrel came to be regarded as a serious pest in forestry plantations because of the damage it can cause to conifers by eating shoots and stripping bark. Bark stripping weakened trees and greatly reduced their financial value, e.g. by making trees useless for telegraph posts (Anderson, 1967; Kenward, 1983). It is known that squirrels were heavily persecuted on some Highland estates from the late 19th century (Ritchie, 1920; Shorten, 1954), and there were calls to systematise squirrel persecution (Fraser, 1907). On Ardross Estate, a survey of woodlands in 1907 showed that in twelve woods of mature trees, seven woods showed slight squirrel damage, three showed moderate damage and one showed severe squirrel damage (Schlich and Pearson, 1907; Hewson, 1953). Grant (in Anderson, 1967) reported that squirrels on Novar Estate attacked woods of ten years and older, after the more mature woods had been felled during the First World War; woods were still being damaged there in 1925 in spite of persecution (see below). Anderson (1924) reported that hundreds of thousands of pounds worth of damage had been caused by squirrels on Lovat Estates. The Royal Scottish Arboricultural Society had tried to take up the squirrel problem, as when it attempted, unsuccessfully, to establish a squirrel club for Inverness-shire in 1924; the Forestry Act (1919) included legal provisions that landowners were to control squirrels, but this provision in the Act was never apparently enforced (Anderson, 1967).

Background to the Club, and Annual Reports

Members of the Squirrel Club were owners of estates who joined voluntarily, and paid a subscription each year based on the area of woodlands on their estates (Table 2). A bonus was paid for each squirrel tail submitted to the Secretary, who kept a record of the number of tails submitted from each estate, and from each estate worker, over the calendar year; bonuses were derived from the subscriptions. Initially, the Club had employed dedicated squirrel-killers and an independent Inspector of Woods, who reported to the Secretary; this system was in operation at least between 1903 and 1907. Other than the employment of dedicated squirrel-killers between these years, there was no evidence of changes in the methods of persecution. It was assumed that changes in numbers of squirrels submitted were attributable to changes in squirrel numbers rather than to changes in methods, excepting the periods of the World Wars, when many estate workers were called up for military service. Bonuses were intended to encourage estate owners and their workers (gamekeepers and forest workers) to persecute Red Squirrels, and, from correspondence, it is known that at least some landowners gave the bonuses directly to their gamekeepers (see also Middleton, 1930).

A.H. Duncan, of Duncan and Duncan, Solicitors, Dingwall, was the Club's Secretary from its inception in 1903 until his retirement from the post in 1938, after which time R.T.W. Wilson Anderson, also of Duncan and Duncan, occupied the post. The position of Secretary was waged and was paid from the subscriptions. The employment of a lawyer as Secretary may have been an attempt to minimise abuse of the scheme, since other such schemes are known to have been abused (see Shorten, 1954). The extent to which the scheme may have been abused is not known, but given that squirrels were abundant in the area at the turn of the 20th century, and that the Secretary was extremely rigorous, such abuse is considered to have been relatively unimportant. It appears that tails were normally destroyed, presumably to minimise the risk of abuse of the scheme.

Annual General Meetings were held in the Convening Rooms of the Council Buildings in Dingwall, generally between January and April. The Secretary reported on the numbers of squirrels submitted, the subscriptions paid, and the bonuses paid to each estate in the previous year; there were generally several members of the Club present, and the subscription rate for the year, plus the amount of bonus per tail, were also set at the A.G.M. The Secretary sent out Annual Reports to subscribers to the scheme; these contain a brief statement of the Annual General Meeting and the activities of the Club during the previous year, together with the subscription due from each estate for the current year. The Reports also include a full statement of the subscriptions paid, the number of

Table 2. Variation in the extent of woodland on each estate

Period	Area of woodland (km^2)		
	n	Mean per estate[1]	95% CI[1]
1903-08	48	2.8	2.0-3.8
1909-13	44	2.8	2.0-3.8
1914-18	42	2.7	1.9-3.7
1919-24	45	2.5	1.8-3.4
1925-29	38	2.8	2.0-3.8
1930-34	36	2.6	1.9-3.6
1935-39	32	2.5	3.5-1.7
1940-46	27	2.3	1.6-3.4
ANOVA	F=0.12, 7 df, NS		

1. Calculated on the mean for each period for each estate.
   Data transformed to Normal distribution by log(x+1) transformation; mean and 95% CI derived by back-transformation.

squirrels killed and bonuses paid accordingly, and the area of woodland, on each estate for the previous year. The numbers of squirrels killed and the bonuses paid for the two previous years were also included for comparison.

Data Extraction

The numbers of squirrels submitted and the acreage of woodland on each estate were extracted from the Annual Reports. For convenience, the years 1903-46 were broken into a number of periods of approximately five years in duration to reduce inter-year variations in numbers submitted. The periods 1903-08 and 1909-13 covered the early years of activity of the Club; the period 1914-18 covered the period of the First World War; the periods 1919-24, 1925-29, 1930-34 and 1935-39 covered the inter-war years and the period 1940-46 covered the Second World War. The extent of woodlands on each estate was converted from acres to square kilometres (km^2). The number of squirrels submitted per km^2 of woodland on each estate in each year was calculated to examine variations in the numbers of squirrels submitted per unit area of woodland. The mean number of squirrels submitted in the years of each period and the mean number of squirrels submitted per km^2 of woodland were calculated for each estate.

The area covered by the Club was divided into geographical units to examine regional variations in the numbers of squirrels submitted. The areas were the Black Isle, East Ross, Mid Ross, West Ross, and East Ness. For the purpose of the present study, the Black Isle included that area lying east of Conon Bridge and Muir of Ord, and East Ross included the area north and east of Dingwall and included two south Sutherland estates. Mid Ross covered the part of Ross-shire west and south of Dingwall as far east as Conon Bridge and Muir of Ord, and as far west as Garve. West Ross included three separate forests, two of which were west of Garve and the other was in Monar forest. East Ness estates were mainly west of the Caledonian Canal, except for six estates south-east of Inverness. Three estates could not be allocated to one or other of these groups because they consisted of sections which lay in different areas; these estates were excluded from the geographical analysis.

Membership of the Club

The original Ross-shire Squirrel Club contained 34 member estates in its founding year, all of which were in Ross-shire except for Beaufort, from where all Ross-shire squirrels may have originated. One additional estate joined in 1904. The Annual Report issued in 1905 records that there was "great benefit from the work of the Club....to young plantations and growing timber of all kinds", and Lord

Lovat proposed that the area of the Club be extended to cover Inverness-shire north of the Caledonian Canal. Ten East Ness estates joined in 1905 and this was found to have "worked very satisfactorily"; the Annual General Meeting of 1906 considered extending the area of the Club to cover Sutherland and the remainder of Inverness-shire in 1906. Four more East Ness estates joined between 1906 and 1908 but only one Sutherland estate subscribed, and then only for 1906-07. The number of estates peaked in 1906 with 47 subscribers, but gradually declined thereafter so that there were only 21 subscribers in 1946; the number of subscribers did not decline during the period of the First World War (see Figure 2).

The Northern Branch of the Royal Scottish Arboricultural Society had proposed forming a Squirrel Club for Inverness-shire in 1924, but there was "an indifferent response" and the proposal was abandoned. Nine parties who had expressed an interest were recommended to join the Highland Squirrel Club and two did so in 1924. One other Sutherland estate became a member between 1923 and 1946. The Forestry Commission, established in 1919 with Lord Lovat as its first Chairman, was one of the nine parties who had expressed an interest and became a member from 1925 until the Club ended its activities in 1946.

Of seventeen subscribers who resigned before 1930, two resigned because there were no squirrels in their areas (1911 and 1920), one resigned since their woods had been sold for removal (1924) and another since they were going to cut their woods (1921). One had sold the estate (1924), one saw "no benefit" from being a member of the Club (1922), one resigned since they did not agree with killing squirrels (a rare sentiment), and ten resigned for unknown reasons. Five estates resigned before the First World War, one resigned during 1914-18, ten resigned between 1919 and 1925 (five of which were in East Ness), and one resigned some time between 1925 and 1929. Of sixteen subscribers who resigned after 1930, one resigned because the woods had been cut (1944), one because the estate had been sold (1945), two were removed because they had not paid their subscriptions (1938) and twelve resigned for unknown reasons. Seven estates resigned during 1930-38, and nine resigned between 1939 and 1946, when the Club ceased activities for unknown reasons. A graph of the Club's activities, which was issued with most Annual Reports from 1924 onwards, was projected until 1981 so the Club evidently planned to exist for much longer than it did, at least at that time.

Variation in the Area of woodlands

The area of woodlands was known for all except one estate and for the Forestry Commission. Although the area of Commission woodlands could have been established from the 1947-49 Forestry Commission Census of Woodlands

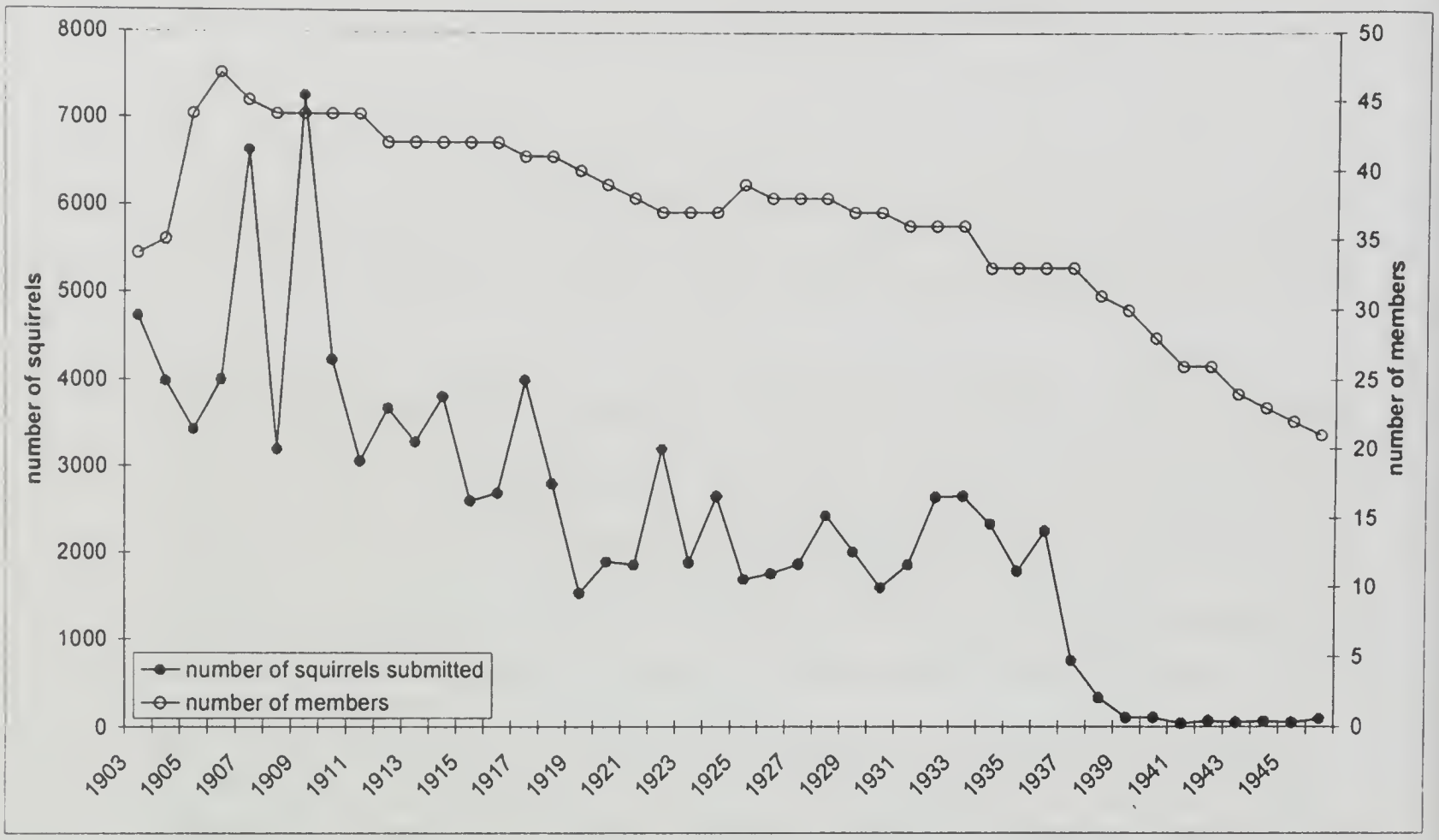

Figure 2

Number of Squirrels submitted per Year and Number of Members

(Forestry Commission, 1952), it was clear that not all woods were old enough to have been suitable habitat for squirrels (see above). Coniferous woodland constituted 92% of high forest in the Census; these woodlands consisted primarily of Scots Pine *Pinus sylvestris*, with smaller amounts of Spruce *Picea* and Larch *Larix*. Most of the high woodland area would have been suitable habitat for Red Squirrels.

The area of woodland covered by the Club obviously changed in line with the number of estates which were members, peaking in 1909. There was no significant variation in the size of individual forests between different areas (ANOVA, F= 0.34, 4 degrees of freedom (df), NS). Some areas, however, were more heavily afforested than others: West Ross had a relatively small amount of woodland coverage, as did the Tarbat Peninsula in East Ross. The remainder of the area was well wooded, mainly below 250 metres, and offered practically continuous woodland between many estates.

Surprisingly, the area of woodlands did not change significantly during the period of the First World War and only one estate reduced its area of woodlands. A further four estates reduced their woodlands during 1921-22; other estates felled woodlands in 1924, 1926, 1931 (2), 1933, 1937 and 1944. Private forests in Ross-shire are known to have had a high proportion of their areas felled by the time of the 1947-49 Census: 65% of the area of private forests (excluding scrub) consisted of areas felled and devastated before 1939; the figure for Inverness-shire was also 65%. The area of woodland covered by the Club in 1938 was 55% of the area covered in 1906 for Ross-shire estates which had subscribed from 1906 (when estate membership peaked). This calculation excludes estates which joined after 1906 and the two estates which are known to have resigned because of a lack of squirrels (rather than a lack of woods). The figure of 55% approximates to the above figure of 65%, so it could be that those estates which resigned for unknown reasons resigned because they had cut their woods; many of the felled areas mapped by the Census appear to correspond with estates which resigned from the Squirrel Club.

Reductions in woodland would appear to have been shortly after the First World War rather than during it. It is possible that, in some cases, there may have been a delay between felling taking place and changes in the area of woodlands being recorded in the Reports, but from correspondence this does not appear to have been true of all cases. The biggest drops in the 1906 area which was still covered by the Club were in 1922 (5%) because of two fellings, 1929 (8%) because one estate resigned, 1934 (6%) because two estates resigned, 1937 (5%) because of felling on one estate, 1939 (9%) because one estate resigned, and 1944

(11%) because one estate resigned. Similarly, some of the areas mapped by the Forestry Commission (1952) as having been felled during the Second World War appear to correspond with member estates of the Squirrel Club, and would explain their resignation and perhaps partly explain the final demise of the Club. The bulk of felling during the Second World War was in private forests, since State forests were still too young to be exploited. Owners of large forests in north and east Scotland had been able to dispose of large areas of woodland which had been badly damaged by squirrels (Anderson, 1967).

Overall Numbers of Squirrels Submitted

The numbers of squirrels killed were very high (Table 1, Figure 2): a total of 102,900 squirrels were submitted for bonus payments between 1903 and 1946. It is unknown what proportion of squirrels killed were submitted, but it has been assumed that the proportion was reasonably constant. The financial incentive may have led to a high proportion of squirrels being submitted, especially since estate workers' wages were low (e.g. Tapper, 1992). The Annual Reports often made reference to the fact that tails were to be submitted to ensure payment of bonuses, and it is known from correspondence that tails were not submitted on a number of occasions; however, the great majority of tails would appear to have been submitted. The numbers of squirrels submitted increased to 1909, when 7,259 squirrels were submitted. Numbers submitted declined thereafter, with the sharpest drop in the number of squirrels being in 1937, when the number of squirrels submitted was only one third of that of the previous year. The numbers of squirrels submitted also fluctuated widely between years.

Numbers of Squirrels Submitted in Relation to the Area of Woodland

The mean number of Red Squirrels submitted per year was directly correlated with the area of woodland on each estate in each time period, except for 1940-46 (t = 10.63, 13.25, 17.05, 12.12, 9.84, 13.35, 4.16, -0.25 for each time period respectively; 46, 42, 40, 43, 36, 34, 30, 25 df respectively; two tailed $P<0.01$ except for 1940-46 when NS). Conversely, and perhaps surprisingly, there was no such correlation between the number of squirrels submitted per km^2 of woodland and the area of woodland on each estate in any time period. (t = -0.01, -0.02, 0.79, 0.03, -0.08, -0.46, -0.73 and -0.9 respectively, NS). This may indicate that squirrels were relatively uniformly distributed throughout woodlands and that persecution was similarly uniform. It is less likely that there was variation in persecution intensity and squirrel density but that they cancelled each other out, since a relatively large number of estates were involved in analyses. An alternative explanation is that, independent of forest size, squirrels varied in density in

woodlands of different types, such as tree species or age structure, thus masking any effect of woodland size.

Changes in the Numbers of Squirrels Submitted

There was significant variation in the number of squirrels submitted from each estate between different time-periods (Table 3). The greatest numbers were submitted during 1903-08, and then numbers declined until 1930-34, when there was a slight recovery. Numbers submitted then declined sharply until the Club ended activities in 1946. Declines were not due simply to changes in the extent of woodland on estates, since the numbers of squirrels submitted per km^2 followed a similar pattern (Table 3). Fraser (1907) commented on how successful the Club had been at controlling the numbers of squirrels in 1903-05. The number of squirrels submitted per km^2 of woodland on estates which were members in both 1909-13 and 1914-18 declined significantly between these two periods (two tailed paired t-test, $t = 3.30$, 41 df, $P < 0.005$; data transformed $\log(x+1)$). The Annual Reports for 1915 and 1916 record that the numbers submitted "were satisfactory considering that many men had been called up for service".

Another estate owner wrote in 1918 that no squirrels had been killed on account of scarcity of ammunition. The numbers declined further between 1914-18 and 1919-24, although not significantly. This is perhaps surprising, since one would expect squirrels to have been less heavily persecuted during the period of the war and therefore allowed to increase. One estate owner corresponded that the number of squirrels on their estate, in 1920, had greatly decreased because of persecution; another related that on their estate, near Invergordon, the squirrels had been nearly exterminated by soldiers and dockyard workers with catapults and gas guns. The number killed in 1923 was not considered satisfactory by the Annual General Meeting, "in view of the large number of squirrels in the country", so squirrels were still common, and Grant (in Anderson, 1967) reported that woodlands were still being damaged by squirrels on Novar estate in 1925.

The number of squirrels submitted declined still further between 1919-24 and 1925-29 ($t = 3.11$, 36 df, $P < 0.005$). One gamekeeper related that squirrels were "very scarce" on an East Ness estate in 1925, although the Annual Report issued in 1928 stated that there were "still a considerable number of squirrels in the district", so that, even at times of low population, squirrels were relatively common. There was a slight increase between 1925-29 and 1930-34, although this was not statistically significant; Middleton (1930) reported that squirrels had increased in Ross during 1925-30, although it is clear that this increase was not found in all areas (see below). There then followed a pronounced decline between 1930-34 and 1935-39 ($t = 4.01$, 31 df, $P<0.0005$), most notably in 1937. This decline continued

Table 3. Variation in the numbers of squirrels submitted from each estate per year

Period	No. of squirrels submitted per estate per year			No. of squirrels submitted per km^2 of woodland per estate per year		
	n	Mean per estate[1]	95% CI[1]	n	Mean per estate[1]	95% CI[1]
1903-08	49	32.6	19.46-53.9	48	13.1	9.2-16.8
1909-13	44	36.1	21.5-60.1	44	14.7	10.2-21.0
1914-18	42	21.4	11.4-39.4	42	8.5	5.4-13.2
1919-24	45	15.9	8.8-28.3	45	6.9	4.3-10.6
1925-29	39	16.0	9.2-27.4	38	6.7	4.4-10.1
1930-34	37	16.9	8.8-31.7	36	8.2	4.8-13.5
1935-39	33	8.4	4.2-16.2	32	4.0	2.2-6.9
1940-46	28	0.8	1.6-0.3	27	0.4	0.1-0.7
ANOVA	F= 9.69, 7 df, P<0.0001			F= 12.42, 7 df, P<0.0001		

1. Calculated on the mean for each period for each estate. Data transformed to Normal distribution by log(x+1) transformation; mean and 95% CI derived by back-transformation.

between 1935-39 and 1940-46 ($t = 5.68$, 26 df, $P<0.0001$). One estate owner enquired if they could get assistance in purchasing ammunition for killing squirrels, but this was dismissed, "as the damage done by squirrels on account of their being so few was negligible" (from minutes of the 1943 Annual General Meeting). If squirrels were causing negligible damage then this may explain the demise of the Club, at least partly. Published squirrel densities in Scottish conifer plantations range between 0.3 and 0.8 squirrels per hectare (Tittensor, 1977; Moller, 1986), so that the numbers of animals killed may have represented only around 10% of the population, if these densities applied in the early 20th century (see Table 3).

Variation in the Numbers of Squirrels submitted from different Geographical Areas

There was significant variation in the numbers of squirrels submitted per km^2 of woodland in different geographical areas in 1903-08, 1909-13 and 1914-18; variation was not statistically significant in other periods when sample sizes were smaller because of reduced Club membership, although there was still considerable variation (Table 4). The highest numbers of squirrels submitted per unit area came from Mid Ross in each period between 1903 and 1934. Very low numbers were submitted from West Ross: two of the three estates which were members, both west of Loch Luichart, were known from correspondence to have no squirrels. The general trend of decline was consistent across all geographical areas from 1914 to 1929, although there were increases on a small number of estates in Mid and East Ross in 1925-29 (Table 5). Increases were found on most Black Isle, Mid Ross and East Ross estates in 1930-34. Increases in Mid Ross were almost exclusively on the north side of the River Conon, whereas most estates to the south and west of the river showed decreases. These forests were more isolated than forests north of the river, or forests in East Ross and the Black Isle. Dispersal would probably have been more difficult, both to and between these forests; this may suggest that squirrels increased in some areas and spread into others, rather than that all increases were the result of increases in the local population. Similarly, increases were not found on estates in West Ross or East Ness between 1925-29 and 1930-34. On each estate in East and Mid Ross, there was no correlation between changes in the numbers of squirrels submitted between 1925-29 and 1930-34 and the area of woodland ($t = -0.387$, 19 df, NS). Decreases were pronounced in all areas in 1935-39 and 1940-46.

Methods of Persecution

There is very little reference to the methods of persecution. Squirrels were known to have been killed with catapults and gas guns near Invergordon around

Table 4. Variation in the numbers of squirrels submitted from each estate per year in different geographical areas

Period	No. of squirrels submitted per km^2 of woodland per year on each estate[1]									
	Black Isle		East Ness		East Ross		Mid Ross		West Ross	
	n	Mean (& 95% CI)	n	Mean (& 95% CI)	n	Mean (& 95% CI)	n	Mean (& 95% CI)	n	Mean (& 95% CI)
1903-08	6	12.3 (3.1-42.3)	14	10.4 (5.1-20.2)	12	15.9 (9.1-27.0)	10	25.9 (17.3-38.6)	3	0.6 (0.0-3.0)
1909-13	5	20.8 (8.8-47.3)	12	10.8 (4.9-22.7)	11	20.1 (14.0-28.5)	10	25.3 (17.0-37.6)	3	0.0 (0.0-0.0)
1914-18	5	13.8 (5.8-31.1)	11	5.2 (1.6-14.0)	11	6.7 (2.3-16.9)	10	18.6 (11.5-29.9)	2	0.0 (0.0-0.0)
1919-24	5	11.9 (7.0-19.8)	13	4.4 (1.1-12.6)	12	6.5 (2.8-14.0)	10	12.9 (6.4-25.1)	2	0.0 (0.0-0.0)
1925-29	5	5.1 (2.9-8.6)	9	7.6 (1.98-23.7)	11	5.4 (2.6-10.5)	10	10.8 (5.3-21.2)	1	0.0
1930-34	4	9.1 (0.8-54.8)	8	6.0 (1.9-15.9)	11	8.8 (3.1-22.4)	10	10.5 (3.8-26.7)	1	0.0
1935-39	4	6.3 (0.5-36.1)	6	2.1 (0.6-5.0)	9	10.2 (4.1-23.8)	10	1.9 (0.3-5.3)	1	0.0
1940-46	4	0.7 (0.0-2.0)	5	0.2 (0.0-0.7)	7	0.9 (0.0-3.3)	8	0.1 (0.0-0.2)	1	0.0
ANOVA	1903-08, F= 4.520, 4 df, P<0.005 1909-13, F= 9.372, 4 df, P<0.0001 1914-18, F= 3.141, 4 df, P<0.05 1919-24, F= 2.222, 4 df, NS 1925-29, F= 1.276, 4 df, NS 1930-34, F= 0.730, 4 df, NS 1935-39, F= 2.234, 4 df, NS 1940-46, F= 0.949, 4 df, NS									

1. Calculated on the mean for each period for each estate. Data transformed to Normal distribution by log(x+1) transformation; mean and 95% CI derived by back-transformation.

Table 5. Variation in trends in the number of squirrels submitted from each estate per year in different geographical areas

Area	Trend[1]	Number of estates						
		1903-08/ 1909-13	1909-13/ 1914-18	1914-18/ 1919-24	1919-24/ 1925-29	1925-29/ 1930-34	1930-34/ 1935-39	1935-39/ 1940-46
Black Isle	Increase	1	1	2	0	3	0	1
	Decrease	1	4	3	4	1	1	3
	No change	3	0	0	1	0	3	0
East Ness	Increase	3	3	0	0	0	0	0
	Decrease	5	5	5	5	4	4	5
	No change	3	3	5	3	4	2	0
East Ross	Increase	3	3	2	3	7	3	0
	Decrease	4	6	4	6	2	4	6
	No change	4	2	4	2	2	2	1
Mid Ross	Increase	3	2	2	3	5	0	0
	Decrease	2	6	6	5	4	8	4
	No change	5	2	2	2	1	2	4
West Ross	Increase	0	0	0	0	0	0	0
	Decrease	1	0	0	0	0	0	0
	No change	2	2	2	1	1	1	1

1. Increase/decrease defined as estates which had a >20% difference in the mean number of squirrels submitted per year from the previous time period

the First World War. Fraser (1907) makes interesting reference to the importance of a trained squirrel dog, stating that these were necessary to keep the squirrel population down. Fraser makes further reference to the fact that, in the early years of the Club, dedicated squirrel-killers were employed in November and May only. Most animals are presumed to have been shot.

Economics of Persecution: Subscriptions and Bonuses

Members of the Squirrel Club paid a subscription fee based upon the acreage of woodland on their estate; no differentiation was made between native and planted woodlands, nor between young and mature woodlands; members did not pay subscriptions on felled areas. The subscription was set at ten shillings for the first 200 acres, plus ½d per additional acre, in 1903-04, and at five shillings for the first 200 acres, plus ¼d to ¾d per additional acre, between 1905 and 1929, except in 1925 when the subscription was raised to six shillings for the first 200 acres, plus ½d per additional acre; the rate was raised in 1925 to help pay for an overdraft resulting from an increase in the number of squirrels submitted (see below). During 1930-39 the subscription was set at six shillings for the first 200 acres, plus ¼d to ½d per additional acre. This changed again in 1940 to three shillings for the first 200 acres, plus ¼d per additional acre, and again in 1941 to three shillings for the first 500 acres, plus ¼d per additional acre; finally, the subscription was set at three shillings for the first 1,000 acres, plus ¼d per additional acre, between 1942 and 1946. The Forestry Commission joined in 1925 on the condition that its subscription would be on a different basis to other members, since most Commission forests were too young to be vulnerable to damage.

The bonus paid was 4d (four pence) per tail between 1903 and 1909, 3d between 1910 and 1923, 4d between 1924 and 1932, and 3d between 1933 and 1938. The bonus was raised to 4d in 1939, 5d in 1940, and 6d between 1941 and 1946. Increases in the bonus in 1924 and from 1939 onwards were intended to encourage greater persecution when the numbers of squirrels submitted decreased (see below). The increase in the bonus in 1924 from 3d to 4d saw the number of squirrels submitted increase by 40% although there were the same number of members, leading to the overdraft mentioned above.

The working of the Club was intended to encourage persecution across the whole of the area, not just on each estate. This meant that estates which killed large numbers of squirrels could make a profit (see Middleton, 1930), although the intention was that the bonuses would be paid to estate workers directly. Profits were made by 1 in 10 estates in 1903 and by approximately half of all estates in 1909 and 1914. The proportion of estates which profited from the scheme was

lower in subsequent periods: 1/20 estates in 1919, 1/6 in 1925, 1/9 in 1930, 1/5 in 1935, 1/28 in 1940 and 1/11 in 1946.

Several members were known to have no squirrels on their estates, and it was clear from correspondence that these estates were members in order to encourage persecution elsewhere to try to ensure that squirrels did not spread onto their estates. Two such estates, west of Loch Luichart, both resigned from the Club before 1920, when squirrels were in general decline elsewhere. Some other estate owners certainly tried to encourage their neighbours to join, and from correspondence it was clear that a certain 'duty' was felt to belong to each estate owner to control squirrels on their estates. The idea of controlling squirrels throughout the area was central to the formation of the Club (Fraser, 1907). As already mentioned, the Forestry Act (1919) had empowered the Commissioners to take action against landowners who failed to control pests, including squirrels, although no such action was apparently ever taken (Anderson, 1967). Lord Lovat, a prominent member of the Club from its earliest days, was a key figure in the formation of the Forestry Commission, and was its first Chairman (see Ryle, 1969). Middleton (1930) recommended that a national squirrel club should be established, along the lines of the Highland Squirrel Club, to help curtail the spread of the Grey Squirrel; Fraser (1907) had made the same call over 20 years earlier.

The current value (i.e. purchasing power) of subscriptions was calculated for 2.5 square kilometres (618 acres) of woodlands, close to the mean area of woodlands on each estate (Table 2). In 1904 this would have been equal to approximately £85 in 2001, in 1914 to £36, in 1919 to £19, in 1925 to £42, in 1930 to £56, in 1935 to £39, and in 1940 to £23. This was a small amount considering that Anderson (1924) reported that damage on Lovat Estates amounted to hundreds of thousands of pounds. Over the period 1903-46, the total subscriptions paid amounted to £2,526 19s 0d, approximately £121,000 in modern terms (equal purchasing power calculated for each year). Similarly, bonuses came to £1,495 8s 8d, approximately £75,000 in modern terms.

As already mentioned, the bonus system was intended to increase persecution effort by financial reward. Unfortunately, the number of gamekeepers and foresters is only known for one estate: Coul, in Mid Ross, where there were two gamekeepers employed. This estate was typical in terms of the numbers of squirrels submitted per km^2 of woodland, and in the general pattern of decline in numbers submitted. The value of bonus payments would have represented 3.4% of the gamekeepers' financial income in 1910, 1.5% in 1915, 0.3% in 1920 and 1925, 0.9% in 1930 and 0.3% in 1935 (based on estate workers' wages given by Mutch in Anderson, 1967); no squirrels were submitted from Coul after 1939.

Fraser (1907) relates that the Squirrel Club had employed squirrel-killers in the months of November and May. These were to receive 21 shillings per week (approximately £60 in present-day terms) when engaged by the Club, plus £3.00 per annum for the upkeep of a dog.

Discussion

Declines in Red Squirrel populations were found throughout Britain in the early 20th century; those in north Scotland came relatively late (Middleton, 1930; Shorten, 1954). These have generally been attributed to disease (e.g. Middleton, 1930). Red Squirrels appear to be commonly infected with coccidiosis, caused by the protozoan *Eimeria sciurorum*, and parapoxvirus, both of which can cause morbidity (Keymer, 1983). Shorten (1954) discusses the decline of Red Squirrels as a combination of the effects of loss of habitat and disease. Predators have also increased as gamekeeping declined through the 20th century and especially after each of the World Wars (Hudson, 1992; Tapper, 1992; McGhie, 2002), although Gurnell (1991) did not consider predation to affect numbers significantly. All of these factors may have had some influence (Hewson, 1953). Red Squirrels probably increased north of the Caldeonian Canal in the 1940s and 1950s (Shorten, 1946 and 1957), perhaps due to increases in habitat following the planting of Forestry Commission forests from the 1920s and restocking of woodlands felled in the World Wars. Red Squirrels, however, have never again reached the population levels attained at the turn of the 20th century. Regional variations in numbers of squirrels submitted, found by the present study, provide novel information on regional variations in density.

The economics of the Club are of interest, since the relative importance of bonuses can be examined. Membership of the Club was relatively inexpensive, considering that squirrels caused severe financial damage. Workers persecuting squirrels could receive significant financial rewards when squirrels were abundant, but not at other times. Declines in the numbers of squirrels and concomitant damage, may mean that the Squirrel Club eventually became uneconomic and therefore redundant.

It is interesting to note the complete change in attitude towards Red Squirrels between the early 20th century and the present time. Far from being persecuted, the Red Squirrel is now a key species for conservation. It has declined throughout much of Britain through the 20th century. The reasons for this are not altogether clear (see above), but once the Red Squirrel disappears from an area it tends to be replaced by the Grey Squirrel. Scotland is of special importance, since it holds over 75% of Britain's Red Squirrels and many parts are still completely free of Grey Squirrels (Harris, Morris, Wray and Yalden, 1995), although the Grey Squirrel is

now increasing in south Scotland (e.g. Gibson and Grant, 1992). The Red Squirrel was listed on Schedule 5 of the Wildlife and Countryside Act, 1981, which legally protected it from interference, including trapping and shooting. The species now has a framework conservation plan and is included in the U.K. Biodiversity Action Plan. Ironically, a new 'Highland Squirrel Club' has even been formed, but members of this now have interests in conservation rather than persecution.

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